and eastward to Lake Michigan, and by the following morning had covered the entire eastern section of the district. Warnings were ordered in advance of this condition in nearly all States threatened, with the exception of the central sections on the 25th. Local frosts occurred in the cranberry marshes of Wisconsin on several dates, and special warnings were issued in every case in advance of them.—*H. J. Cox, Professor and District Forecaster.*

DENVER FORECAST DISTRICT.*

[Wyoming, Colorado, Utah, New Mexico, and Arizona.]

The month presented no marked abnormal features. There was less than the average amount of precipitation generally thruout the district, and in Utah the mean temperature was somewhat below normal. Frost was confined to central and northern portions of the district, and at moderate elevations was generally light. Accurate and timely warnings were issued of frost that occurred in agricultural sections.—*F. H. Brandenburg, District Forecaster.*

SAN FRANCISCO FORECAST DISTRICT.†

[California and Nevada.]

The month was unusually cool in the Sacramento and San Joaquin valleys. Light rains occurred along the coast and showers and thunderstorms in the Sierra and Nevada on the 3d, 4th, and 5th. Light rain fell in the extreme northern portion of California on the 17th, 24th, and 27th, and light snow in the Sierra on the 28th. No frost or storm warnings were issued.—*G. H. Willson, Local Forecaster.*

PORTLAND, OREG., FORECAST DISTRICT.†

[Oregon, Washington, and Idaho.]

The month was unusually quiet and temperature and rainfall were nearly normal. Storm warnings were ordered on two dates for minor disturbances, and all frosts were successfully forecast.—*E. A. Beals, District Forecaster.*

RIVERS AND FLOODS.

There was little of interest during the month, and no floods occurred, except along the lower portion of the James River, in which the stages reached exceeded the flood line. Warnings were issued for the Ocmulgee and Oconee rivers in Georgia, the Wateree River in South Carolina, the James River in Virginia, and for the Binghamton district in New York.

No damage has been reported, except from the Binghamton district where the excessive rains caused washouts in the railroad beds and flooding by backwater from the sewers.

The highest and lowest water, mean stage, and monthly range at 202 river stations are given in Table VI. Hydrographs for typical points on seven principal rivers are shown on Chart I. The stations selected for charting are Keokuk, St. Louis, Memphis, Vicksburg, and New Orleans, on the Mississippi; Cincinnati and Cairo, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.—*H. C. Frankenfield, Professor of Meteorology.*

* Morning forecasts only; night forecasts made at Washington.
† Morning and night forecasts.

SPECIAL ARTICLES, NOTES, AND EXTRACTS.

ON ATMOSPHERIC CURRENTS AT VERY GREAT ALTITUDES.

By Prof. C. C. TROWBRIDGE. Contributed from the Phoenix Physical Laboratory, Columbia University, New York, N. Y., September 5, 1907.

In a recent abstract[1] the writer gave a brief summary of the results of a study of the luminous and long-enduring streaks or trains which are occasionally formed by large meteors. A complete discussion of the physical nature of these trains, with some additional facts recently determined, will appear shortly in the Astrophysical Journal.[2] The present paper relates to the atmospheric currents which are shown to exist in the extreme upper regions of the atmosphere of the earth by the observed drifting of these luminous trains.

The systematic observation and study of meteor trains is of much importance to meteorology because it is the only means by which the presence as well as the direction and velocity of atmospheric currents at very great altitudes above the surface of the earth can be determined. There has been little, if any, systematic work done in this direction heretofore. It is possible that one of the chief reasons for this fact is that the observations of meteor trains have been made almost entirely by astronomers, often in an incidental manner when engaged in other work; while the results obtained relating to the atmosphere and principally of interest to meteorologists have been published in astronomical journals and hence overlookt by those most interested in the subject.

Meteor trains are apparently self-luminous clouds which are usually deposited by large meteors, and particularly those that are swift moving, like the Leonids and Perseids. Astronomers who have made frequent meteor observations are familiar with the phenomenon, but few have taken up the matter further than to make records of the trains which they have seen. There are some notable exceptions. E. E. Barnard is the author of a paper entitled "Drifting meteor trains",[3] in which he gave the directions and rates of drift of five trains seen at Nashville, Tenn., having southeasterly and northeasterly drifts, and called attention to the importance of the observation of meteor-train drifts as a means of studying the movements of the atmosphere. W. F. Denning and A. S. Herschel have referred on many occasions to the drifts in England, and in a number of cases have calculated the altitude and in some the rate of drift of trains. H. A. Newton, C. A. Young, E. E. Barnard, and others have reported them in the United States from time to time. The astronomical journals contain records of train observations made in various countries all over the world.

The study of meteor trains was undertaken by the writer in order to find an explanation of the mysterious persistent luminosity of trains seen at night in the light of recent advances in physics, particularly relating to the conduction of electricity in gases, recombination of the gaseous ions, etc., and a solution of this problem seems promising. In the course of the work there has been found much valuable material relating to the movements of the upper currents in our atmosphere, which is brought together in the present paper.

Many of the trains studied are those which occurred from 1860 to 1870, when meteor observations were more numerous than usual, owing to the interest in the great Leonid showers of 1866, 1867, and 1868, but some of the most important records are of recent date. A number of bright trains were seen during the Leonid shower of 1901. In working up the records it was frequently necessary to determine the direction of the atmospheric drifts by reference to a celestial globe, for in many cases the movements of the trains with respect only to stars were found in the records.

The train drifts given in the present paper do not represent all the recorded observations on the subject, for, owing to the magnitude of the work, it has been possible for the writer to cover only a portion of the field, and the conclusions drawn are thus necessarily based on but a part of the available material. However, over sixty observations of meteor-train drifts have been found. These are given in Tables

[1] Physical Review, June, 1907, p. 524.
[2] Astrophysical Journal, XXVI, 2, Sept., 1907.
[3] Sidereal Messenger, I, 174, 1883; reprinted in 1891.